LAT Improvement of Engine driven Screw Compressor using separate entry for Air Inlet

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***Abstract*—LAT (Limiting Ambient Temperature) of the Engine and Compressor is a key operating parameter. To improve the LAT separate air intake for compressor and engine is provided. The comparative evaluation shows improvement of LAT around 10 degrees.**

***Index Terms*— Limiting Ambient Temperature, LAT of Compressor, LAT of Engine, Compressor Performance.**

I. INTRODUCTION

Every compressor and engine has limited range of operating temperature. Higher operating temperature results in overheating of lubricating oil, and poor performance of the machine. Original Equipment Manufacturer specifies the temperature range and operating parameters of the machine. The Maximum atmospheric temperature at which machine can be operated safely is known as "Limiting Ambient Temperature of the Machine". The Limiting Ambient Temperature commonly known as LAT which depends on cooler capacity, and vaporization temperature of the coolant or cooling oil. In case of oil injected screw compressor it is dependent on Oil temperature and in case of Engine it is dependent on the coolant temperature. If compressor reaches maximum temperature of oil, then the controller shutdown the compressor unit. Similarly if the engine reaches the maximum temperature then controller will shutdown the engine. Shutting down compressor element or engine can be achieved by unloading and shutting down the compressor unit. The LAT of the compressor unit is dependent on the limiting temperature of the prime mover and the compressor element. Improving LAT of the Compressor Unit results in wide range of operating temperature thus the machine becomes more useful for practical applications. Researchers are trying various techniques of optimizing the cooling capabilities of the compressor element. Oil flow and air flow changes are the main factors considered in recent research. [1] [2] [3]

II. VARIOUS TECHNIQUES OF IMPROVING LAT OF COMPRESSOR UNIT

Improving LAT means improving cooling capability of the compressor unit so that compressor can be used in higher ambient temperature. LAT can be improved by improving cooling performance or by reducing heat generated in the unit. Engine driven oil injected screw compressor is considered in this paper. Main contributors of heat generation in compressor unit are fuel burning in engine and heat rejected by compressed hot air. Compressed air temperature will be low if inlet air temperature is low and vice versa. Screw Compressor element and engine continuously radiates the heat to its surroundings which keeps internal temperature of the compressor unit higher than the external ambient temperature. Figure 1 shows the schematic representation of the conventional arrangement of compressor unit.

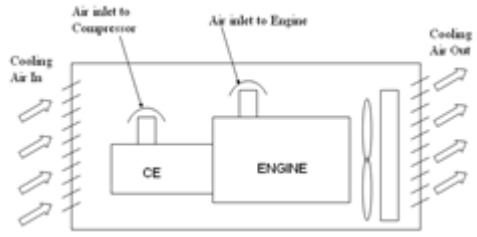

Fig 1. Schematic Layout of Compressor Unit.

Separate air intake duct will avoid heating of air within compressor unit. Hence if separate air inlet duct is provided for the Compressor element and Engine then air intake temperature of the compressor and engine will be low. Fig. 2 shows schematic representation of the Compressor unit with the separate entry for Air Intake. This paper describes the implementation of separate entry to engine and compressor element and it was found beneficial to improve LAT.

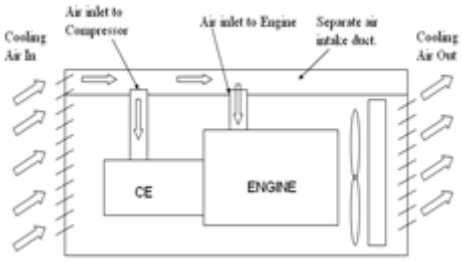

Fig 2. Schematic Layout of Compressor Unit with separate air intake duct

III. DEFINITIONS AND TERMINOLOGIES

A. LAT of Compressor:

LAT of oil injected screw compressor depends on maximum temprature of the lubricating oil. The highest temprature of Oil is at the compressed ait outlet port of the compressor element. The formula for calculating the LAT of the compressor element is writen below, LAT element = (120– t outlet Element)/1 + Ambient Temperature

B. LAT of Engine:

The LAT of the engine depends on the maximum temprature of the coolant.

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The formula for the Engine LAT measurement is as below, LAT engine = (95 – t outlet coolant engine)/1 + Ambient Temperature If the ambient temperature increases then the air outlet temperature of compressor element and outlet temperature of engine coolant will also increase. 120 and 95 degrees are the limiting temperatures of the lubricating oil and engine coolant respectively.

Comparative evaluation of the calculated LAT is done for the ambient temperature range of 24 to 26 degrees Celsius.

IV. IMPLEMENTING SEPARATE ENTRY FOR AIR INLET.

Air inlet duct sizing is done considering the air intake requirements of engine and compressor element. The calculations are done as follows,

A. Air requirement of Engine:

Air intake requirement of engine is 413 l/s, at tested operating speed.

B. Air requirement of Compressor Element:

Air requirement of the compressor is equal to its free air delivery, which is equal to 481.3 l/s

Therefore total Air quantity requirement = 894.3 l/s

Considering Air Inlet Velocity 7m/s maximum air velocity the Open Area requirement is = 0.127 m^2. The air intake duct is designed to provide the required area.

V. TESTING OF THE PROPOSED SYSTEM.

The compressor unit is tested with and without the separate air intake duct. Operating parameters are kept same during the test. The testing results are as follows,

A) LAT measurement with out separate air entry.

Thermocouples PT 1000 are used at following locations.

T1: Atmospheric Temperature Outside compressor unit.

T2 : Compressed air-oil outlet port.

T3 : Coolant out engine.

The Table 1 shows the Observations of these temperatures.

TABLE I:
READINGS WITHOUT SEPARATE AIR INLET

[1] T1	[2] T2	[3] T3
[4] 24.5	[5] 101.5	[6] 84.5
[7] 25.5	[8] 102.8	[9] 85.7
[10] 26.2	[11] 103.6	[12] 86.4

The calculated LAT for above readings is shown in Table 2.

TABLE II:
LAT WITHOUT SEPARATE AIR ENTRY

[13] Ambient Temperature	[14] LAT Compressor Element	[15] LAT Engine
[16] 24.5	[17] 53	[18] 35
[19] 25.5	[20] 52.7	[21] 34.8
[22] 26.2	[23] 52.6	[24] 34.8

B) LAT measurement with separate air entry.

Thermocouples PT 1000 are used at same locations.

T1: Atmospheric Temperature Outside compressor unit.

T2 : Compressed air-oil outlet port.

T3 : Coolant out engine.

The Table 3 shows the Observations of these temperatures.

TABLE III:
READINGS WITHOUT SEPARATE AIR INLET

[25] T1	[26] T2	[27] T3
[28] 24.1	[29] 91.8	[30] 73.7
[31] 25	[32] 93.1	[33] 74.1
[34] 26.3	[35] 93.8	[36] 74.9

The result of LAT is shown in Table 4.

TABLE IV:
LAT WITHOUT SEPARATE AIR ENTRY

[37] Ambient Temperature	[38] LAT Compressor Element	[39] LAT Engine
[40] 24.1	[41] 62.3	[42] 45.4
[43] 25	[44] 61.9	[45] 45.9
[46] 26.3	[47] 62.5	[48] 46.4

VI. CONCLUSION

The result shows clear improvement in LAT of the Compressor and Engine. The LAT of Compressor is improved by 9-10 degree Celsius and LAT of Engine improved by 10-11 degree Celsius. Hence providing separate air entry for the compressors and engine improves the Limiting Ambient Temperature of the unit.

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REFERENCES

[1] N. SESHAIAH, R.K. Sahoo, S.K. Sarangi, "Theoretical and experimental studies on oil injected twin-screw air compressor when compressing different light and heavy gases", Journal of Applied Thermal Engineering, pp 327-339, October 2009

[2] N. Seshaiah, S.K. Ghosh, R.K. Sahoo, S.K. Sarangi, "Performance analysis of oil injected twin screw compressor", 18th National and 7th ISHMT-ASME Heat and Mass Transfer Conference, India, pp 145-155, June 2006

[3] M. Fujiwara, Y. Osada, "Performance analysis of oil injected screw compressor and its application", International Journal of Refrigeration, pp 220-227, December 1995.

[4] X. Peng, Z. Xing, X. Zang, T. Cui, P. Shu, "Experimental study of oil injection and its effect on performance of twin screw compressors", International Compressor Engineering Conference, Purdue, USA, pp. 1003–1010, April 2000.

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